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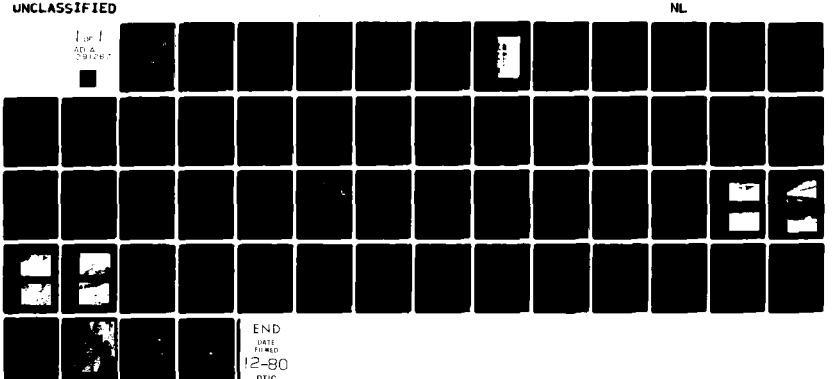

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PATAPSCO RIVER BASIN
JONES FALLS, BALTIMORE CITY

MARYLAND

DRUID HILL LAKE

NDI ID NO. MD-109

CITY OF BALTIMORE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

DACW31-80-C-0050

By
RUMMEL, KLEPPER & KAHL
Consulting Engineers
Baltimore, Maryland 21202

JULY 1980

PATAPSCO RIVER BASIN,
JONES FALLS, BALTIMORE CITY,
MARYLAND

National Dam Inspection Program

DRUID HILL LAKE

(NDI-ID ~~No.~~ MD-109)

Number

~~CITY OF BALTIMORE~~
~~DEPARTMENT OF PUBLIC WORKS~~

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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Prepared for:
DEPARTMENT OF THE ARMY
Baltimore District Corps of Engineers
Baltimore, Maryland 21203

10 Edward J. Zeigler

By:
RUMMEL, KLEPPER & KAHL
Consulting Engineers
1035 N. Calvert Street
Baltimore, Maryland 21202

July 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PATAPSCO RIVER BASIN

JONES FALLS, BALTIMORE CITY

MARYLAND

DRUID HILL LAKE

NDI ID NO. MD-109

CITY OF BALTIMORE
DEPARTMENT OF PUBLIC WORKS

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

July 1980

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION
AND RECOMMENDED ACTION

Name of Dam:	Druid Hill Lake NDI ID No. MD-109
Size:	Large (1880 acre-feet 119 feet high)
Hazard Classification:	High
Owner:	City of Baltimore Department of Public Works 600 Municipal Office Building Baltimore, Maryland 21202
State Located:	Maryland
City Located:	Baltimore
Stream:	Jones Falls
Dates of Inspection:	June 17, 1980 and July 15, 1980

Based on the visual inspection, available records, past operational performance, and in accordance with the guideline criteria established for these studies, Druid Hill Lake Dam is judged to be in fair condition.

Druid Hill Lake is impounded by an earthfill dam consisting of a northern, eastern, and southern embankment. The lake is a reservoir for filtered water which is pumped from the Montebello Water Purification Plant. The dam, completed in 1871, was recognized by the American Society of Civil Engineers in 1971 as a National Historical Civil Engineering Landmark.

The water level of the reservoir is maintained at approximately elevation 212. The maximum pool level of elevation 216 represents the top elevation of the overflow pipe located at the eastern end of the reservoir. Water normally leaves the reservoir by gravity flow through an outlet header at the eastern end of the lake.

Because all inflow into the reservoir is controlled, with the exception of rainfall directly on the lake and a small amount of surface runoff, flood routing and detailed hydraulic and hydrologic analyses are not required.

The downstream slope of the eastern embankment is heavily vegetated with small trees, shrubs, and brush, making inspection of the slope difficult. A 70+ foot wide earth slump was noted approximately at the middle of the eastern embankment. The slump extends from the crest of the embankment to the toe of the slope at the Jones Falls Expressway exit ramp ditch and appears to be a shallow, as opposed to deep seated, slump. Between this slump and the vent chamber located approximately 200 feet north of the slump, the downstream slope is characterized by an undulating surface and zones of surface erosion. Minor slumps having the potential to develop into larger earth movements may exist in this area, but the dense vegetation obscured the ground surface at the time of inspection. Based on these observations, embankment stability problems exist at Druid Hill Lake, and a further investigation is warranted.

The following remedial measures are recommended to be accomplished by the Owner in a timely manner:

1. Retain the services of a Registered Professional Engineer experienced in the design and construction of embankment dams to evaluate the need to remove the trees having diameters greater than 4 inches that are growing on the southern and eastern embankments. If removal is recommended, the Professional Engineer should also recommend a method of root removal and refill to prevent the formation of voids in the embankment caused by root decomposition.

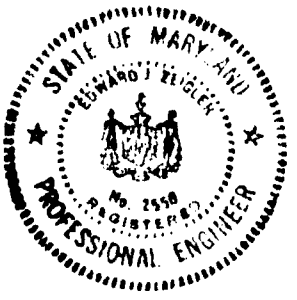
2. Remove all shrubs, brush and trees having a diameter less than 4 inches from the downstream slope of the eastern embankment and develop a regular program of cutting the vegetation on the slope.

3. Retain the services of a Registered Professional Engineer experienced in the design and construction of embankment dams to: a) re-inspect the eastern embankment after the vegetation has been removed to determine the total extent of slumping; b) investigate the cause of the existing earth slumps; and c) recommend remedial measures for repairing the slope.

4. Repair the existing earth slumps and any other slumps noted after vegetation has been removed from the slope. Repairs should be made according to recommendations given by the Professional Engineer who investigates the slumps.

5. Repair all areas of surface erosion and erosion gullies.

6. Develop a formal warning system to alert the downstream residents and industries along the Jones Falls in event of an emergency.



Submitted by:

RUMMEL, KLEPPER & KAHL

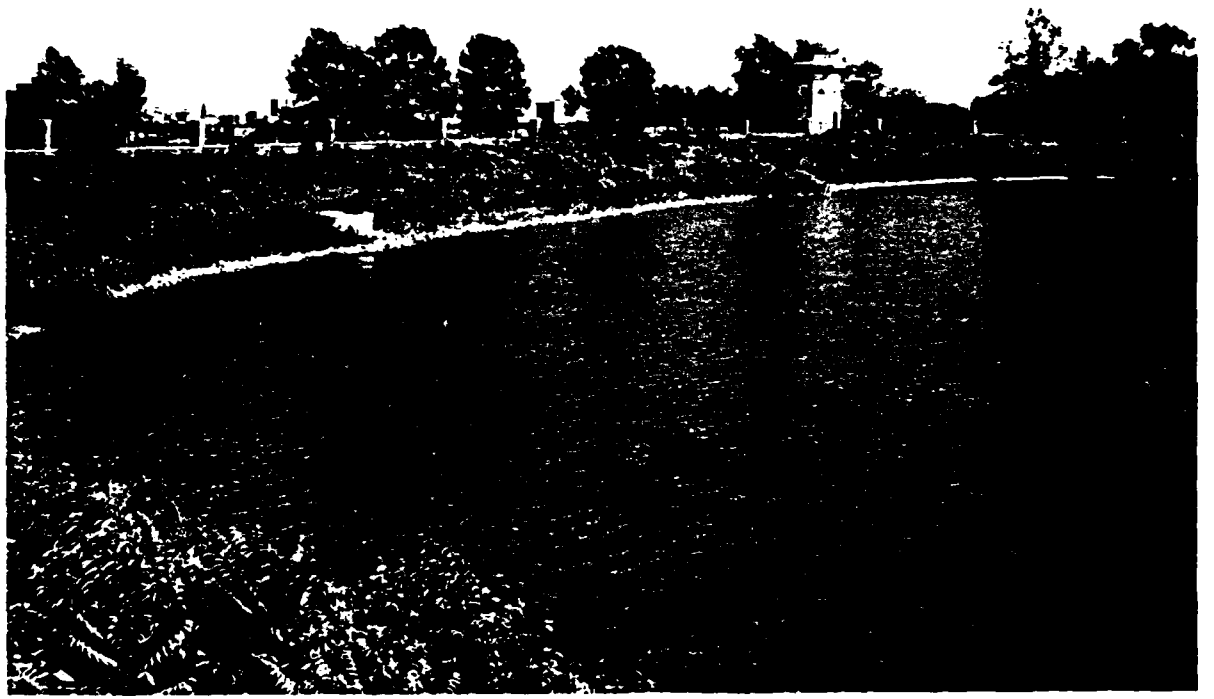
Edward J. Zeigler, P.E.
Associate

Date: August 26, 1980

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer
Date: 22 Sep 1980

DRUID HILL LAKE



AN OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DRUID HILL LAKE
NDI ID NO. MD-109

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the dam inspection program is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. The Druid Hill Lake, completed in 1871, is used for finished water storage and distribution for the Baltimore City water supply. Water is supplied to the reservoir from the Montebello Water Purification Plant by gravity flow through an 84-inch tunnel to just east of the lake, and then through a 72-inch inlet main to an inlet header located at the west end of the lake. Outflow from the reservoir is conveyed by gravity to the Baltimore First Water Service Zone distribution and, during periods of high demand, to the Vernon Pumping Station for pumping to either Ashburton Reservoir or Guilford Reservoir. Water levels of the lake are recorded regularly. Because all significant inflow into the reservoir is controlled, detailed hydraulic and hydrologic analyses have not been performed.

The various features of the dam and impoundment are shown on the photographs in Appendix C and on the Plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Druid Hill Lake is located in the Jones Falls drainage basin in Baltimore, Maryland. The reservoir is shown on U.S.G.S. Quadrangle, Baltimore West, Maryland, at latitude N 39° 19' 0" and longitude W 76° 37' 54". A location map is included as Plate E-1.

c. Size Classification. Large (119 feet high, 1880 acre-feet). The maximum height of the dam is based on the dimension shown on the typical section included as Plate E-2 of this report. The original downstream toe of the eastern embankment of the dam has been covered by construction of the Jones Falls Expressway.

d. Hazard Classification. High hazard. Industry is found on either bank of the Jones Falls downstream of the dam.

e. Ownership. City of Baltimore, Department of Public Works, 600 Municipal Building, Baltimore, Maryland 21202.

f. Purpose of Impoundment. Finished water storage for Baltimore City Water Distribution System.

g. Design and Construction History. Construction of the Druid Hill Lake Dam was started in 1864 and was completed in 1871. The dam was designed by and constructed under the supervision of Robert K. Martin, Chief Engineer of the Baltimore Water Board at that time. A limited amount of design information and construction drawings for the dam were available from the City of Baltimore. Construction drawings illustrating modifications to the piping system were also available from the city.

h. Normal Operating Procedure. Finished water from the Montebello Water Purification Plant is fed to the lake by gravity through an 84 inch tunnel and a 72 inch water main. Water enters the lake through an inlet header at the west end of the lake. Water levels are generally maintained at elevation 212. The maximum pool level is elevation 216, which corresponds with the top of elevation of the riser pipe located at the eastern end of the dam. Water is conveyed from the impoundment by gravity to either Baltimore's First Water Service Zone distribution system and, during periods of high demand, to Vernon Pumping Station for pumping to either Ashburton or Guilford Reservoirs.

1.3 Pertinent Data.

a. Drainage Area. Not applicable.

b. Discharge at Dam Site. Not applicable

c. Elevation (Baltimore City Datum)(Feet).

Top of Dam	224.2(low point on crest)
Maximum Pool	216 (overflow to storm drain)
Normal Pool	212
Upstream Invert Outlet Works	Not Applicable
Downstream Invert Outlet Works	Not Applicable
Streambed at Centerline of Dam	Not Applicable
Maximum Tailwater	Not Applicable
Downstream Toe	+106± (Toe currently covered by fill for Jones Falls Expressway)

d. Reservoir Length (Feet).

Normal Pool	2700 (East to West)
Maximum Pool	2730 (East to West)
Top of Dam	2850 (East to West)

e. Storage (Acre-Feet).

Normal Pool Level	1180
Maximum Pool Level	1390
Top of Dam	1880

f. Reservoir Surface (Acres).

Normal Pool Level	49
Maximum Pool Level	51
Top of Dam	57

g. Dam.

Type	Earthfill
Length	3000± feet
Height	119' maximum
Volume of Fill	570,000± cu. yds.
Top of Width	50± feet
Side Slopes	Downstream: 1V:2H
	Upstream: 1V:4H
Zoning	Yes
Impervious Core	Puddled Trench Core
Cutoff	None
Grout Curtain	None

h. Regulating Outlet.

Type	Pressure Type
Length	Not Applicable
Closure	Gate Valves
Access	Valve House
Regulating Facilities	Overflow structure

i. Spillway. Not Applicable

SECTION 2
DESIGN DATA

2.1 Design.

a. Data Available. A limited amount of design information and construction drawings for the dam were available from the City of Baltimore. Selected as-built drawings for improvements made to the Druid Lake inlet, outlet, and overflow works dated 1958 are also available.

(1) Hydrology and Hydraulics. No hydrologic or hydraulic design data is available. The records included a "Storage Capacity vs. Elevation" curve for the reservoir, and piping diagrams for the present operation of the reservoir.

(2) Embankment. With the exception of a typical section of the proposed embankment, the only design information for the embankment is contained in a few technical reports which discuss the historical significance of Druid Lake Dam.

(3) Appurtenant Structures. Diagrams and some construction drawings are available for the piping system and inlet and outlet facilities.

b. Design Features.

(1) Embankment. The typical section and limited technical information indicate that the embankment is constructed as a succession of earthfill embankments, each having a puddled trench in the core of the embankment. The upper layer of the upstream slope of the reservoir was constructed using a puddling technique and covered with riprap from the crest to the toe. A stone wall was constructed along the toe of the upstream slope.

(2) Appurtenant Structures. Original design data is not available, but selected as-built drawings for improvements made to the Druid Lake inlet, outlet, and overflow works dated 1958 have been provided by the City of Baltimore.

c. Design Data.

(1) Hydrology and Hydraulics. No design data is available.

(2) Embankment. Other than the typical section the dam embankment obtained from the City of Baltimore, the only design data is contained in a few technical articles which discuss the historical significance of Druid Lake Dam. The typical section is included in Appendix E.

2.2 Construction. A brief description of construction methods employed in building the dam is included in an article entitled, "The High Earth Dam Forming Druid Lake, Baltimore Water-Works", which appeared in the February 20, 1902 issue of Engineering News.

2.3 Operation. The reservoir is an active part of the Baltimore City Water Distribution System. Presently, finished water from the Montebello Water Purification Plant is fed by gravity to the Druid Hill Lake. All inflow into the impoundment is controlled by a 60-inch butterfly valve on the 72-inch inlet main located north of the lake. The water level is normally maintained at elevation 212 by the interaction of inflow from Montebello and outflow through the outflow header located at the eastern end of the reservoir. Reservoir water levels are sensed via a pressure sensor on a 30-inch outlet main in the valve house and are recorded continuously at remote recorders at both the Ashburton and Montebello Water Purification Plants.

2.4 Other Investigations. A few test borings were drilled by the City of Baltimore in 1959 to provide information for constructon of the "29th Street Interchange" exit from the southbound Jones Falls Expressway. No design report summarizing results of the investigation could be located, but the test boring logs were obtained from the Interstate Division of Baltimore City.

2.5 Evaluation.

a. Availability. Detailed design information on the embankment and original hydraulics for the Druid Hill Lake are not available.

b. Adequacy. The available data is not sufficient to allow for a technical assessment of the embankment. Current operating procedures are well documented and considered adequate to evaluate the hydraulic aspects of Druid Hill Lake.

SECTION 3
VISUAL INSPECTON

3.1 Findings.

a. General. The on-site inspection of Druid Hill Lake consisted of:

(1) Visual inspections of the embankment and embankment toe.

(2) Visual examination of the appurtenant structures.

(3) Evaluation of the hazard potential.

The specific observations are shown on plate A-1.

b. Embankment. The general inspection of the embankment consisted of a searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, an observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

The downstream slope of the eastern embankment is heavily vegetated with small trees, shrubs, and underbrush, making inspection of the slopes difficult.

A 70 ± foot wide earth slump was noted near the middle of the downstream slope of the eastern embankment. The slump extends from the crest of the embankment to the toe of the slope at the ditch line of the exit ramp from the Jones Falls Expressway. The slump, characterized by trees within the slump tilting downslope, tension cracks in the soil, and bare soil exposed at the top of the slump, appears to be a surface phenomenon. City officials have been aware of the slump since 1979, and are particularly concerned about the buried concrete conduit carrying chlorine which was partially exposed by the earth movement.

Between the slump and the vent chamber located approximate 200 feet north of the slump, the ground surface is undulating. Zones of surface erosion were noted near the crest of the embankment, and an erosion gully was noted extending from the crest to the toe of the slope at the ditch line of the Jones Falls Expressway exit ramp. These features suggest that minor slumps having the potential to develop into larger earth movements may exist in the area.

The downstream slope of the southern embankment is heavily vegetated, but only a few small erosion gullies were noted. Approximately the western half of the southern embankment has been landscaped with forsythia shrubs and mulch.

The downstream slope of the northern embankment is grass covered. The upstream slope of the entire lake is covered with honeysuckle. No erosion or riprap failures were noted on the upstream slope.

The crest of the embankment varies in elevation by approximately 16 inches. Freeboard at the time of inspection was approximately 13 feet. The embankment crest profile is included as Plate C-2.

c. Appurtenant Structures. The appurtenant structures consist of the overflow and the valve house located in the southeast corner of the dam at the downstream toe. The overflow structure appeared to be in good condition. The interior of the valve house was not inspected.

d. Reservoir Area. The reservoir area consists solely of the area within the embankment, and is in good condition.

e. Downstream Channel. Not applicable. The area downstream of the dam consists of the Jones Falls Expressway and the floodplain of the Jones Falls. At a point approximately 120 feet north of the downstream toe of the northern embankment and 170 feet east of the tennis courts, a zone of wet soil was noted above the 72 inch inlet main which feeds the reservoir. Maintenance personnel of the City of Baltimore report that the 72 inch main leaks at that location and they are currently trying to repair the leak.

3.2 Evaluation. The visual examination and observations of Druid Hill Lake indicate that the southern and northern embankments are in generally good condition. At least one earth slump exists on the downstream slope of the eastern embankment, and zones of surface erosion, an erosion gully, and an undulating ground surface indicative of shallow earth movements were noted north of the slump. Based on the potential for loss of life and extensive property damage, a high hazard classification is warranted for Druid Hill Lake.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. Because Druid Hill Lake forms an important part of the water distribution system for Baltimore City, the operation of the impoundment is well defined and continuous from day to day.

4.2 Maintenance of the Dam (Embankment). The maintenance of the embankment is considered fair. The downstream slope of the eastern embankment is heavily vegetated with small trees, shrubs, and brush, and it is apparent that the vegetation has not been cut for a long time. The trees on the downstream slope of the southern embankment are large, with diameters generally exceeding 12 inches, and it probably would not be practical to remove them. The brush on both the eastern and southern embankments should be cut on a regular basis to facilitate proper inspection of the slopes. No measures have been taken to stabilize the earth slumps or to repair the surface erosion noted on the downstream slope of the eastern embankment.

4.3 Maintenance of Operating Facilities. The City of Baltimore maintains the mechanical and electrical equipment as required because of the importance of the lake to the City's water distribution system. Maintenance records for the equipment are available from the Pumping Section, Bureau of Water and Waste Water, Baltimore City.

It should be noted that a zone of wet soil was noted above the 72" inlet main which feeds the reservoir at a point approximately 120 feet north of the downstream toe of the northern embankment and 170 feet east of the tennis courts. Maintenance personnel of the City of Baltimore report that the 72" main leaks at that location and they are currently trying to repair the leak.

4.4 Warning System. No formal warning system exists for the lake.

4.5 Evaluation. The maintenance of the operating equipment is good, and the maintenance of the embankment is fair. It is recommended that the Owner remove all small trees from the eastern embankment and remove all shrubs and brush from the eastern and southern embankments to facilitate inspection of the slopes. The Owner should retain the services of a Registered Professional Engineer experienced in dam design and construction to re-inspect the eastern embankment after vegetation has been removed, to determine the extent of the earth slumps, to investigate the cause of the slumps, and to recommend a means of stabilizing the slumps.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. Original design data for the hydraulics and hydrology of Druid Hill Lake are not available. Photocopies of "Storage Capacity vs. Elevation Curves" curves for Druid Hill Lake have been obtained from the City of Baltimore. A tabulation of reservoir storage versus pool elevation is included as Page D-2 of Appendix D.

Because all inflow with the exception of rainfall on the lake is controlled, hydraulic and hydrologic analyses have not been performed for Druid Hill Lake. The hazard classification for this impoundment is considered high.

b. Experience Data. The reservoir water levels are monitored utilizing a pressure sensor on a 30-inch outlet main in the valve house and are recorded continuously at remote recorders located at the Ashburton and Montebello Water Purification Plants. Recorded water levels are checked for accuracy several times a month with water level readings taken from reservoir staff gage. There is no information that would indicate that there has ever been a problem with Druid Hill Lake storing or passing rainfall from severe storms including hurricanes.

c. Visual Observations. Visual examination of the embankment, appurtenant structures, and downstream floodplain indicate that there are no problems with the hydraulic and hydrologic aspects of Druid Hill Lake.

d. Overtopping Potential. According to the hydrologic and hydraulic calculations, the dam will not overtop following a storm having an intensity equal to the Probable Maximum Precipitation. Inflow to the lake can be shut off by closing a 60-inch butterfly valve located in the 72-inch main just north of the northern dam abutment. If lowering the reservoir level is necessary, the reservoir can be isolated from Baltimore City's distribution system and drained via a 30-inch drain to the Jones Falls. No evidence exists that Druid Hill Lake ever overtopped or has been in danger of overtopping.

e. Spillway Adequacy. There is no spillway for Druid Hill Lake but the existing outlet mains to the City's distribution system and the existing auxiliary overflow structure and drain are considered adequate for the manner in which the reservoir is operated. If it is arbitrarily assumed that the overflow structure did not function during the occurrence of

a 100 percent Probable Maximum Flood (PMF) event, Appendix D computations demonstrate that all uncontrolled inflow to Druid Hill Lake can be contained within the impoundment with about 6.1 feet of freeboard remaining between the PMF pool level and the top of the dam.

f. Downstream Channel. In the event of dam failure, with no defined downstream channel, water flow would be eastward, across the Jones Falls Expressway and adjacent railroad yard and industrial area, and into the Jones Falls. A high hazard classification is therefore warranted for Druid Hill Lake.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) Even though dense vegetation obscured the ground surface of the downstream slope of the eastern embankment, a 70 ± foot wide earth slump was identified near the middle of the embankment. The slump extends from the crest of the embankment to the toe of the slope at the ditch line of the Jones Falls Expressway exit ramp. Between this slump and the vent chamber located approximately 200 feet north of the slump, the downstream slope is characterized by an undulating surface and zones of surface erosion. Minor slumps having the potential to develop into larger earth movements may exist in this area. These conditions could possibly adversely affect the structural stability of the eastern embankment. Consequently, it is recommended that a Professional Engineer experienced in dam design and construction be retained to investigate the cause of the slumps and to recommend remedial measures to repair the slope.

(2) Appurtenant Structures. The structural condition of the appurtenant structures is considered to be satisfactory.

b. Design and Construction Data.

(1) Embankment. What little data exists does not include any quantitative data to aid in assessing the structural stability of the dam. The available construction drawings and limited technical information indicate that the embankment has a puddled trench core. The earth slump which was observed could adversely affect the stability of the eastern embankment of the dam if, because of lack of attention, it develops into a deep-seated earth movement or if a serious erosion problem develops.

(2) Appurtenant Structures. Available information does not provide adequate data to assess the structural adequacy of the appurtenant structures.

c. Operating Records. The structural stability of the dam is not considered to be affected adversely by the operational features of the dam.

d. Post-Construction Changes. Construction drawings obtained from the City of Baltimore show modifications made to the inlet, outlet, and overflow structures.

e. Seismic Stability. Druid Hill Lake is located in Seismic Zone 1. Based on visual observation, the static stability of the dam appears to be adequate. Consequently, the dam should present no hazard from earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Assessment. Based on the condition of the downstream slope of the eastern embankment, on which was observed a 70 ± foot wide earth slump and a 200 ± foot wide zone of potential earth movement located north of the slump, the Druid Hill Lake dam is considered to be in fair condition. If the earth slumps are not repaired, they could develop into significant earth movements which would adversely affect the embankment stability in the future.

Because essentially all inflow into the lake can be controlled, the hydraulic and hydrologic aspects of the project are not significant.

b. Adequacy of Information. The available information on the design and construction of Druid Hill Lake is limited. Because of the way the water level is controlled, and because of the fact that essentially no runoff enters the impoundment, the available information is considered adequate for the Phase I report.

c. Urgency. Measures recommended below should be implemented in a timely manner.

d. Necessity of Additional Information. The downstream slope of the eastern embankment should be re-inspected after the dense vegetation has been removed. In addition, an investigation should be made by a Professional Engineer experienced in dam design and construction to determine the cause of the instability and to recommend corrective action.

7.2 Recommendations/Remedial Measures

The following remedial measures are recommended to be accomplished by the Owner:

a. Retain the services of a Registered Professional Engineer experienced in the design and construction of embankment dams to evaluate the need to remove the trees having diameters greater than 4 inches that are growing on the southern and eastern embankments. If removal is recommended, the Professional Engineer should also recommend a method of root removal and refill to prevent the formation of voids in the embankment caused by root decomposition.

b. Remove all shrubs, brush and trees having a diameter less than 4 inches from the downstream slope of the eastern embankment and develop a regular program of cutting the vegetation on the slope.

c. Retain the services of a Registered Professional Engineer experienced in the design and construction of embankment dams to: a) re-inspect the eastern embankment after the vegetation has been removed to determine the total extent of slumping; b) investigate the cause of the existing earth slumps; and c) recommend remedial measures for repairing the slope.

d. Repair the existing earth slumps and any other slumps noted after vegetation has been removed from the slope. Repairs should be made according to recommendations given by the Professional Engineer who investigates the slumps.

e. Repair all areas of surface erosion and erosion gullies.

f. Develop a formal warning system to alert the downstream residents and industries along the Jones Falls in event of an emergency.

APPENDIX A

VISUAL INSPECTION CHECKLIST

PHASE I

APPENDIX A
VISUAL INSPECTION CHECKLIST
PHASE I

Name of Dam: Druid Hill Lake **County (or City):** Baltimore City **State:** Maryland

NDI ID. No.: MD-109 **Type of Dam:** Earth **Hazard Category:** High

Date(s) Inspection: 6/17/80 & 7/15/80 **Weather:** Partly Cloudy **Temperature:** 70's

Pool Elevation at Time of Inspection: 212± **M.S.L. Tailwater at Time of Insp.** N/A **M.S.L.**

Inspection Personnel:

J. D. Nauman

J. Wise

Review Inspection Personnel:

E. J. Zeigler

J. G. Mintiens

J. D. Nauman

J. D. Nauman **Recorder**

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Several tension cracks were noted on the eastern embankment within the 70± wide earth slump.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	The 70± wide earth slump noted on the eastern embankment extends from the crest to the toe at the Jone Falls Exp. ramp.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	1) 70± wide earth slump on eastern embankment 2) zone of possible slumping extends 200± north of 70± slump. 3) surface erosion within this zone	Remove vegetation to facilitate inspection; have P.E. evaluate extent and cause of slump(s) & recommend means of repairing slump(s)
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment satisfactory Vertical alignment of highest embankment varies by 16 inches	
RIPRAP FAILURES	None	

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	N/A	
ANY NOTICEABLE SEEPAGE	Seepage noted approximately 170 feet due east of tennis courts, occurring over location of 72-inch water line from Ashburton	City officials are aware of seepage
STAFF GAGE AND RECORDER	Water level gage is attached to Gate House	
DRAINS	N/A	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N/A	
INTAKE STRUCTURE	72-inch ϕ pipe from Ashburton, submerged, discharges near fountain through inlet header	
OUTLET STRUCTURE	Outlet header located at east end of reservoir	
OUTLET CHANNEL	N/A	
EMERGENCY GATE	Overflow structure located at east end of reservoir, approx. 8 feet wide	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

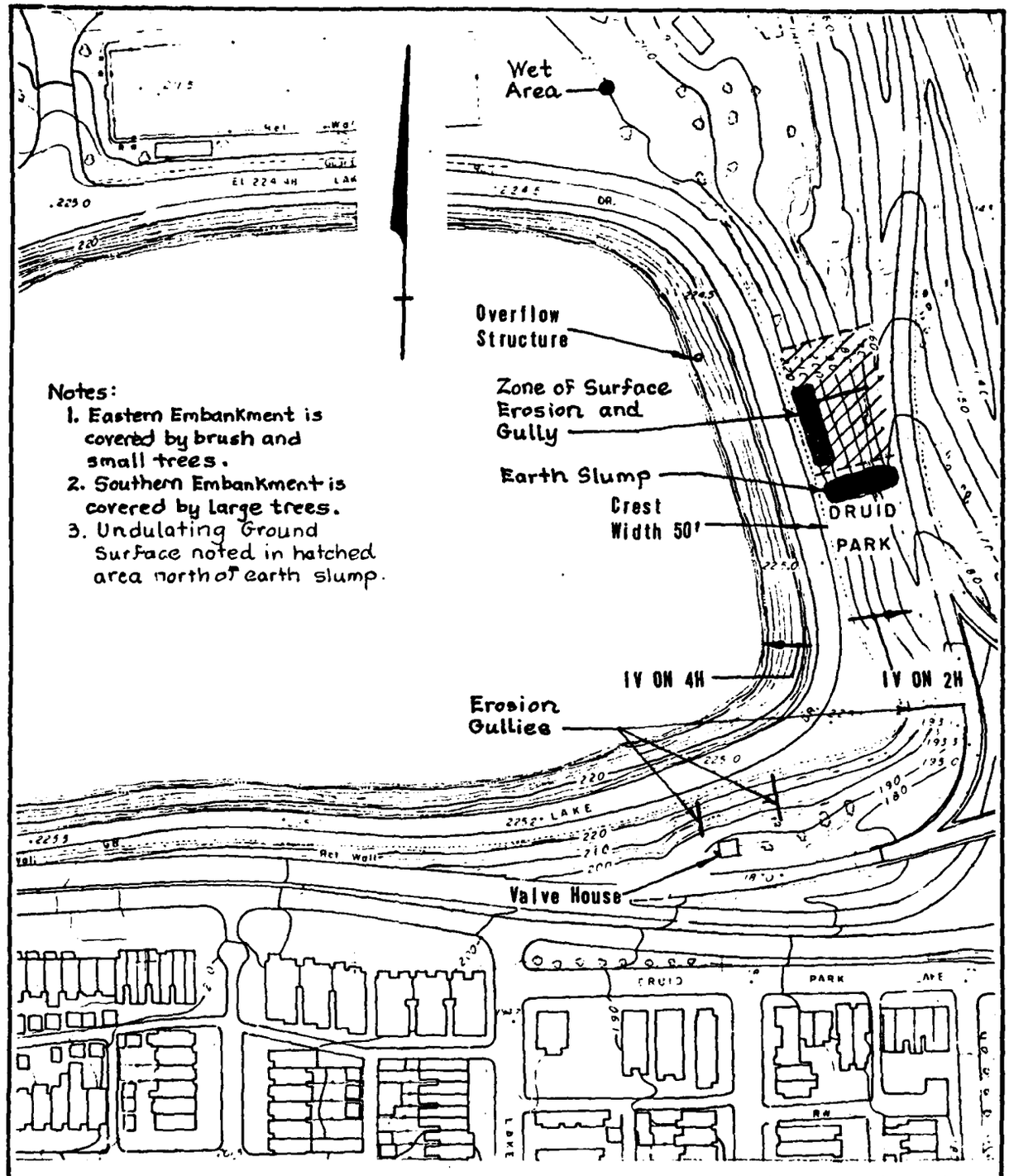
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Riprap at water level Vegetation from top of riprap up to fence line (honeysuckle)	
SEDIMENTATION	None noted	
UPSTREAM RESERVOIRS	N/A	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	N/A	
SLOPES	N/A	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Water would flow east into Jones Falls. Jones Falls Expressway at base of embankment	Numerous industries located along Jones Falls downstream of Druid Lake



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DRUID HILL LAKE

CITY OF BALTIMORE

RESULTS OF
VISUAL INSPECTION

JULY 1980

PLATE A-1

APPENDIX B

ENGINEERING DATA CHECKLIST

PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Druid Hill Lake

ID# NDI I.D. No Md-109

ITEM	REMARKS
AS-BUILT DRAWINGS	Record drawings showing improvements to the reservoir inlet, outlet, and overflow works for Druid Hill Lake are on file with Baltimore City. The drawings are as follows: "Improvements at Druid Lake Reservoir", CWO 30248, April, 1958
REGIONAL VICINITY MAP	Druid Hill Lake is shown on essentially all maps of Baltimore City
CONSTRUCTION HISTORY	Construction commenced March 1864 Construction completed January 1871
TYPICAL SECTIONS OF DAM	A typical section of the embankment has been obtained from Baltimore City and is included as Plate E-2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See above remarks regarding improvements at Druid Hill Lake.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not Applicable
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	UnKnown

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	Unknown
HIGH POOL RECORDS	Available through Baltimore City Bureau of Water and Waste Water, Pumping Section (Water levels recorded continvously)

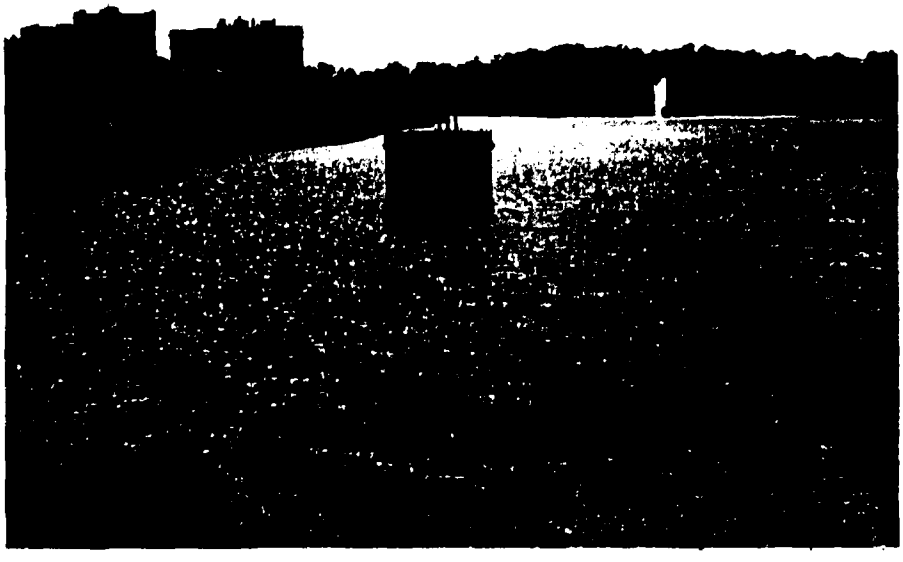
CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Unknown
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown
MAINTENANCE OPERATION RECORDS	Maintenance and Operation Records are maintained on Mechanical/Electrical Equipment by Baltimore City, Bureau of Water and Waste Water, Pumping Section
SPILLWAY PLAN SECTIONS DETAILS	Not Applicable
OPERATING EQUIPMENT PLANS AND DETAILS	Unknown

APPENDIX C

PHOTOGRAPHS

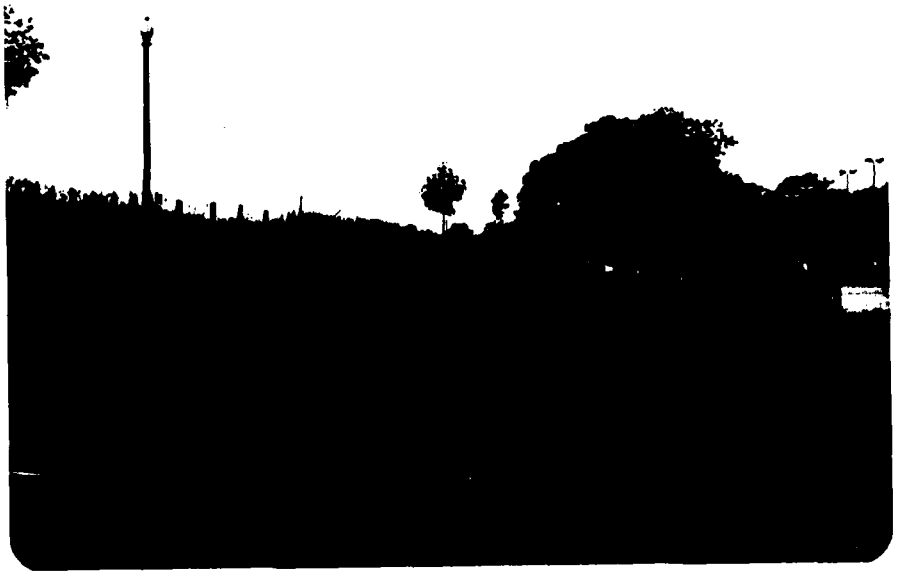
DRUID LAKE



A. Southeast corner of reservoir and gate house

B. Northeast corner of reservoir and overflow structure

C. Downstream slope of southern embankment



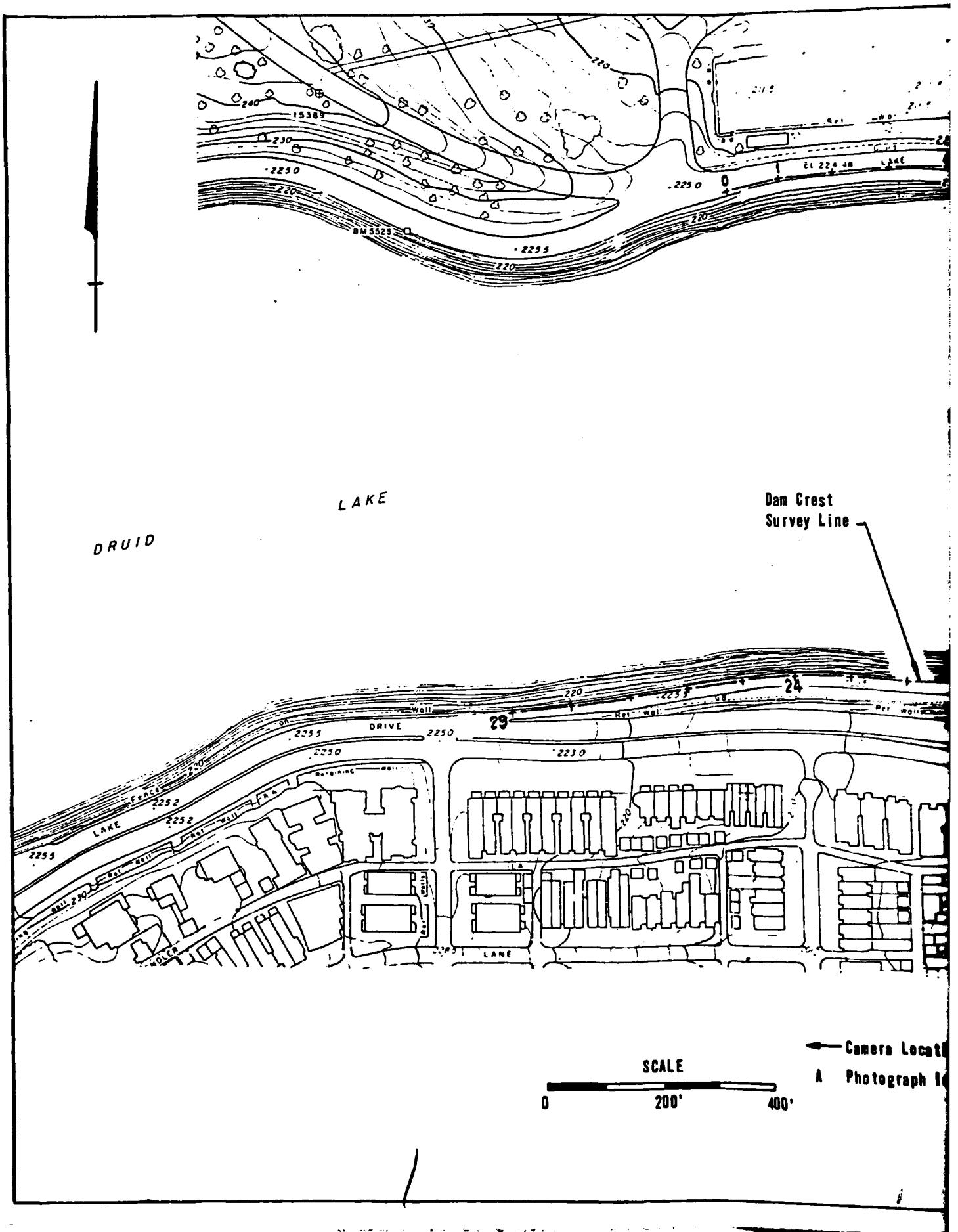
D. Downstream slope of northern embankment

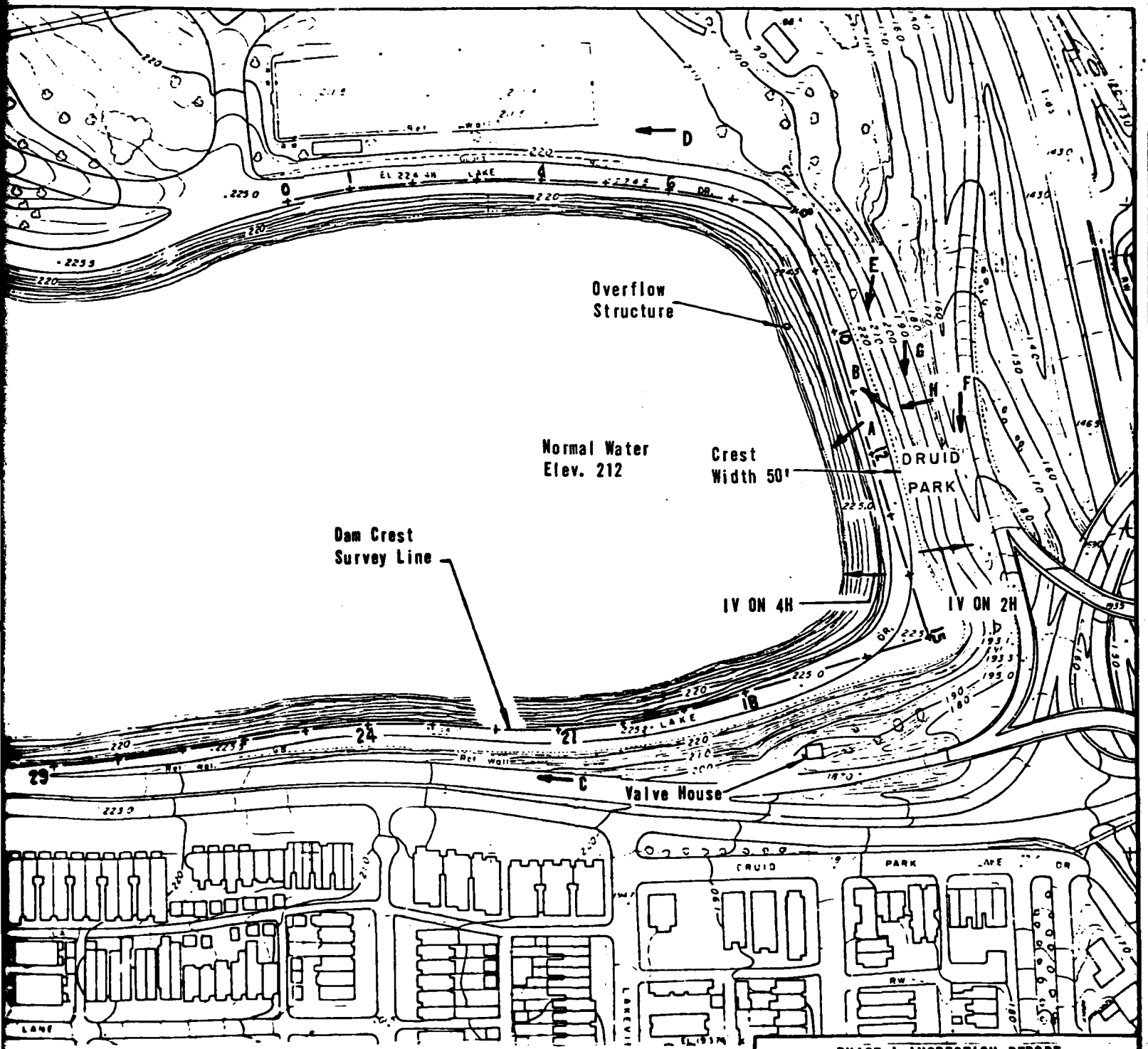
E. Downstream slope of eastern embankment

F. Trees at toe of eastern embankment

G. Erosion at top of eastern embankment has exposed a terra cotta pipe

H. Erosion has exposed soil at the top of the eastern embankment


LAKE
DRUID
Dam Crest
Survey Line
DRIVE
LAKE
LANE
SCALE
0
200'
400'
Camera Locati
A Photograph l



Camera Location And Direction

A Photograph Identification Letter

SCALE

0 200' 400'

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

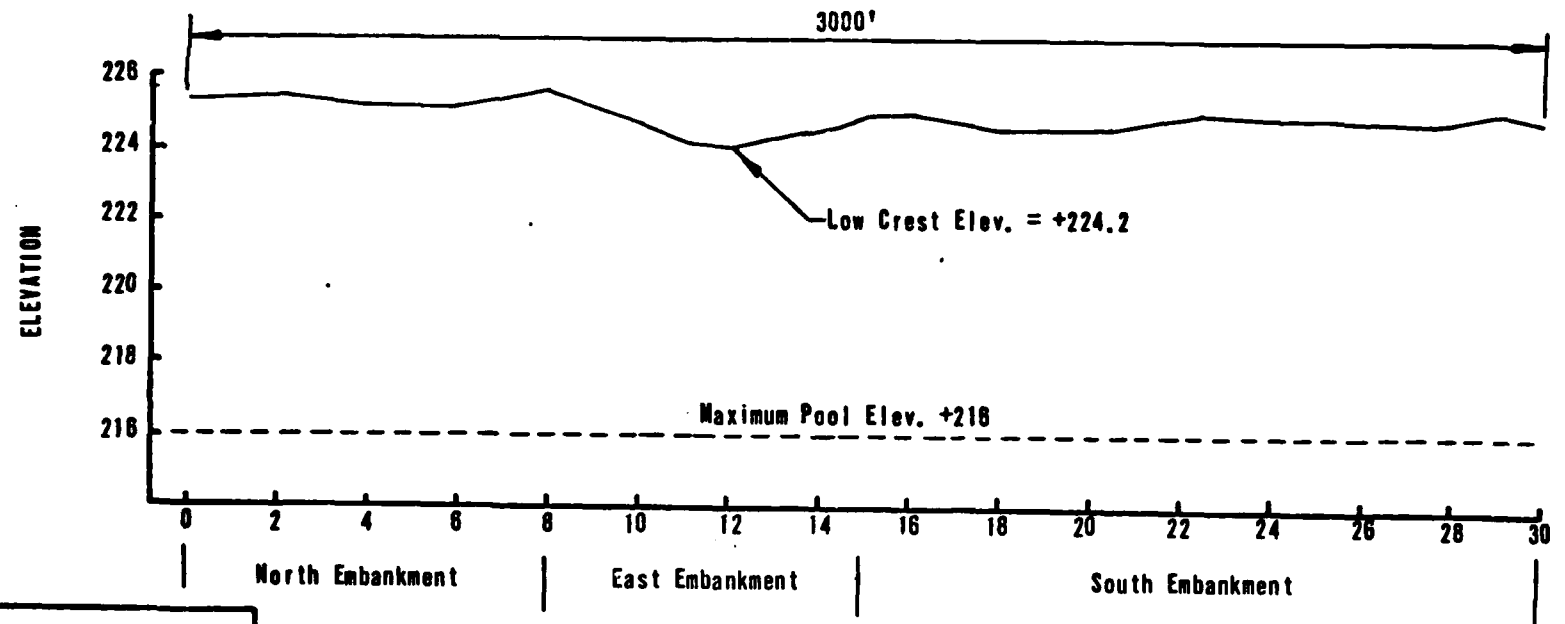
DRUID HILL LAKE

CITY OF BALTIMORE

GUIDE TO LOCATION OF PHOTOGRAPHS

JULY 1980

PLATE C-1



DAM CREST PROFILE

(LOOKING DOWNSTREAM)

NOTE:

DAM CREST SURVEY STATIONS ARE SHOWN ON PLATE C-1

DATUM ELEVATION IS INTERPOLATED FROM 100 SCALE PHOTOGRAMMETRY OBTAINED FROM THE CITY OF BALTIMORE.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DRUID LAKE

CITY OF BALTIMORE

DAM CREST SURVEY

JULY 1980

PLATE C-2

APPENDIX D

HYDROLOGY AND HYDRAULICS

EVALUATION OF AFFECTS OF
MAXIMUM PROBABLE PRECIPITATION
UPON RESERVOIR WATER SURFACE

Name of Dam: Druid Hill Lake (NDI-ID MD-109)

Drainage Area: (Lake Surface Area at Maximum Pool) = 0.080 sq. miles

Unadjusted Probable Maximum Precipitation (PMP) = 24.2 inches/24 hrs. for 200 square miles

Adjusted PMP for Shape Factor for 200 Square Miles = 24.2 inches/24 hrs. x .80 = 19.4 inches/24 hours[1,2]

Adjusted PMP for Drainage Area = 19.4 x 132% = 25.6 inches/24 hours[1] for 10 square miles

(Note: PMP curves from Hydrometeorogical Report 33 do not extend beyond drainage area of less that 10 square miles. While the lake surface area is substantially less that this value, no extension of the published curves has been attempted.)

Maximum Pool Elevation = 216 feet above m.s.l.

Pool Elevation Following Occurrence of PMP of 24 hour Duration = 216 + 2.1 feet = 218.1 feet above m.s.l.

(Note: Pool elevation derived above conservatively assumes that overflow structure is not functioning during occurrence of PMP.)

Top of Dam Elevation = 224.2 feet above m.s.l. (low point)

Remaining Freeboard = 224.2 - 218
= 6.1 feet

Conclusion: Dam would not be cvertopped following storm having an intensity equal to PMP derived above.

[1] Hydrometeorological Report 33, U.S. Army Corps of Engineers, 1956
[2] Engineering Circular 1110-2-27, U.S. Army Corps of Engineers, August, 1966.

Tabulation of Reservoir Storage Capacity Vs. Pool Elevation[1]

Name of Dam: Druid Hill Lake (NDI-ID MD-109)

Pool Elevation feet above m.s.l.[2]	Surface Area acres	Reservoir Storage acre-feet
135 (Reservoir Bottom)	-	0
180	-	200
185	-	270
190	-	360
195	-	480
200	-	640
205	-	850
210	-	1080
215	-	1340
216 (Maximum Pool)	51[3]	1390
224.2 (Top of Dam)	57[3]	1880[4]

---

[1] Source: Druid Lake Capacity Curve, City of Baltimore, Department of Public Works, Bureau of Water Supply, April 3, 1929.

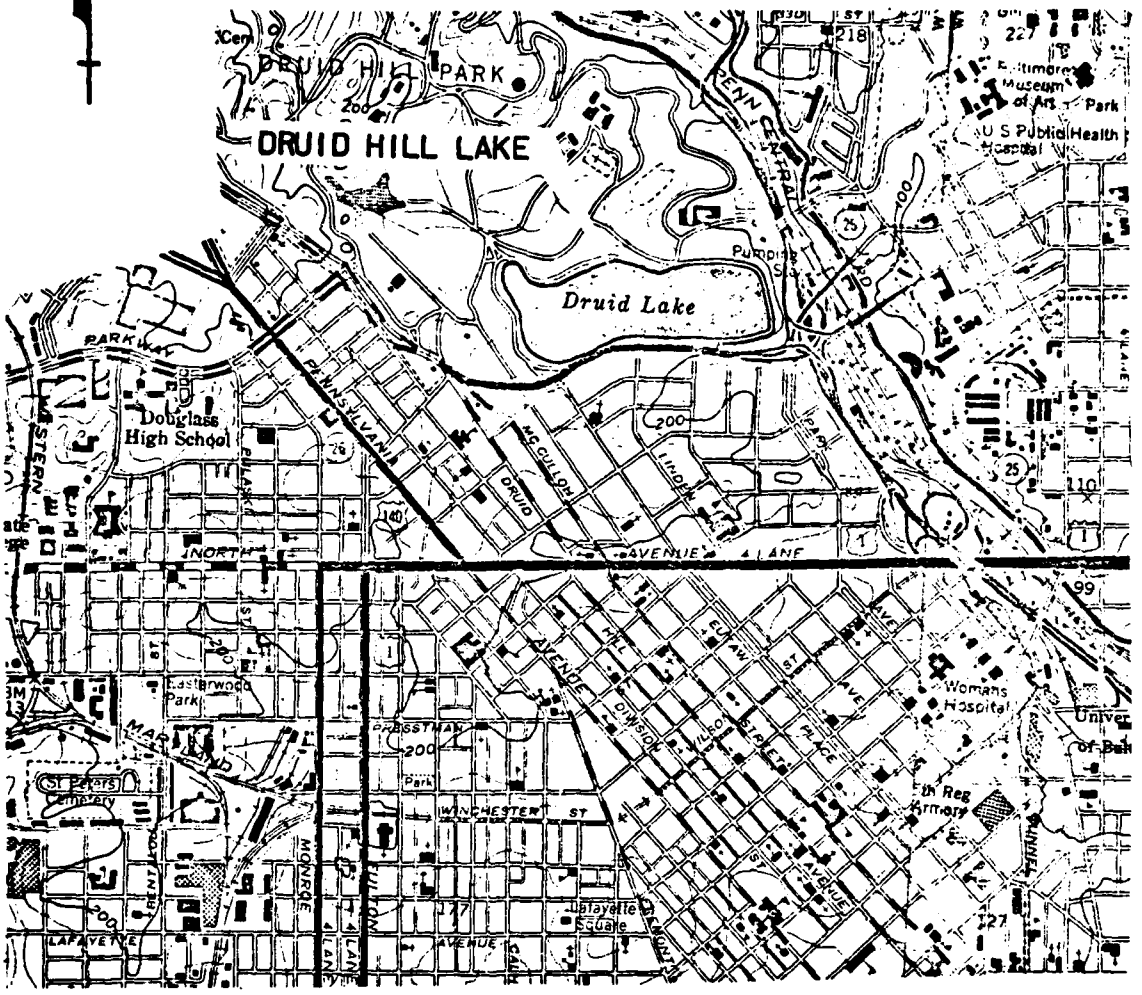
[2] Baltimore Topographical Survey Datum

[3] Area planimetered from a reduction of Baltimore City 100-scale photogrammetric mapping.

[4] Computed by Rummel, Klepper & Kahl.

APPENDIX E

PLATES



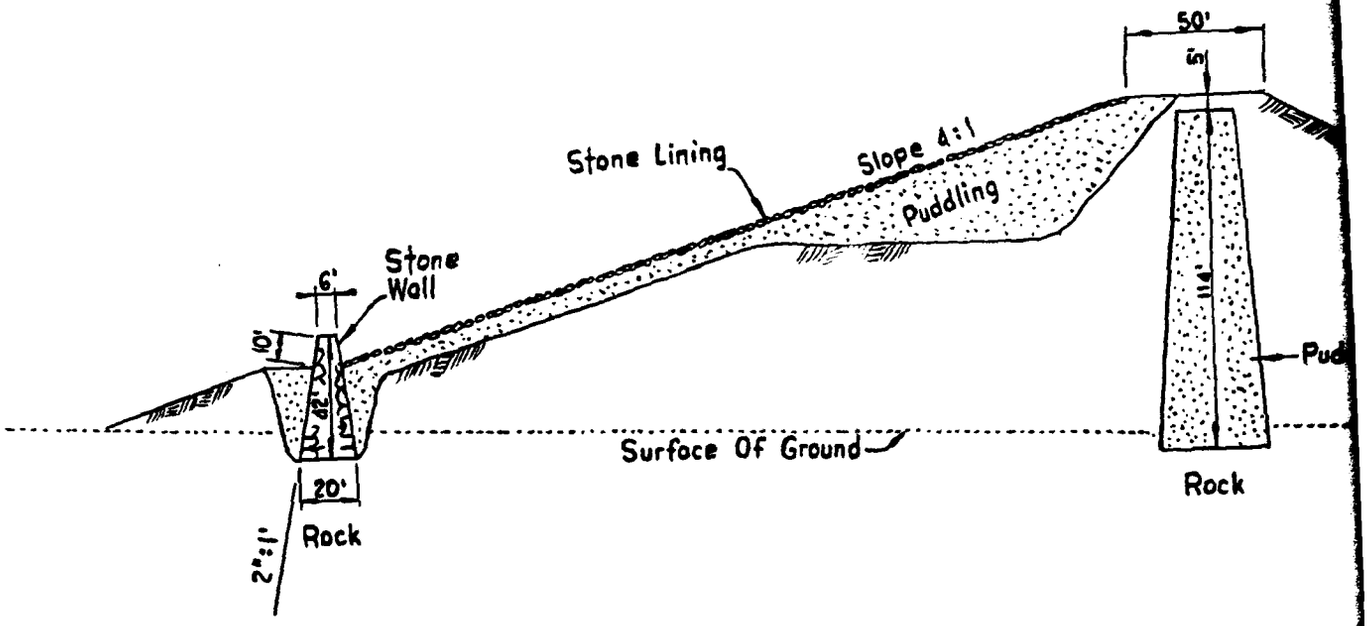
SCALE

0 ½ MI. 1 MI.

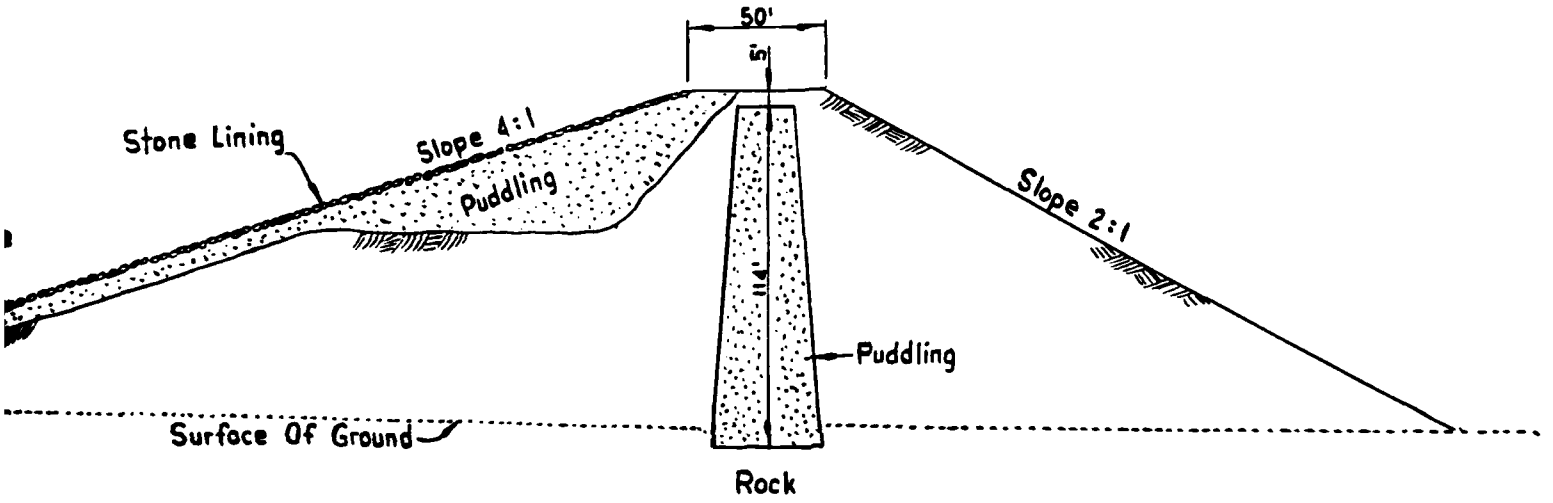
DRUID HILL LAKE

LOCATION MAP

PLATE E-1


50'
Stone Lining
Slope 4:1
Puddling
Stone
Wall
6'
10'
42'
20'
Rock
2":1'
Surface Of Ground
Rock

Scale 1" = 60'



Scale 1" = 60'

TYPICAL SECTION

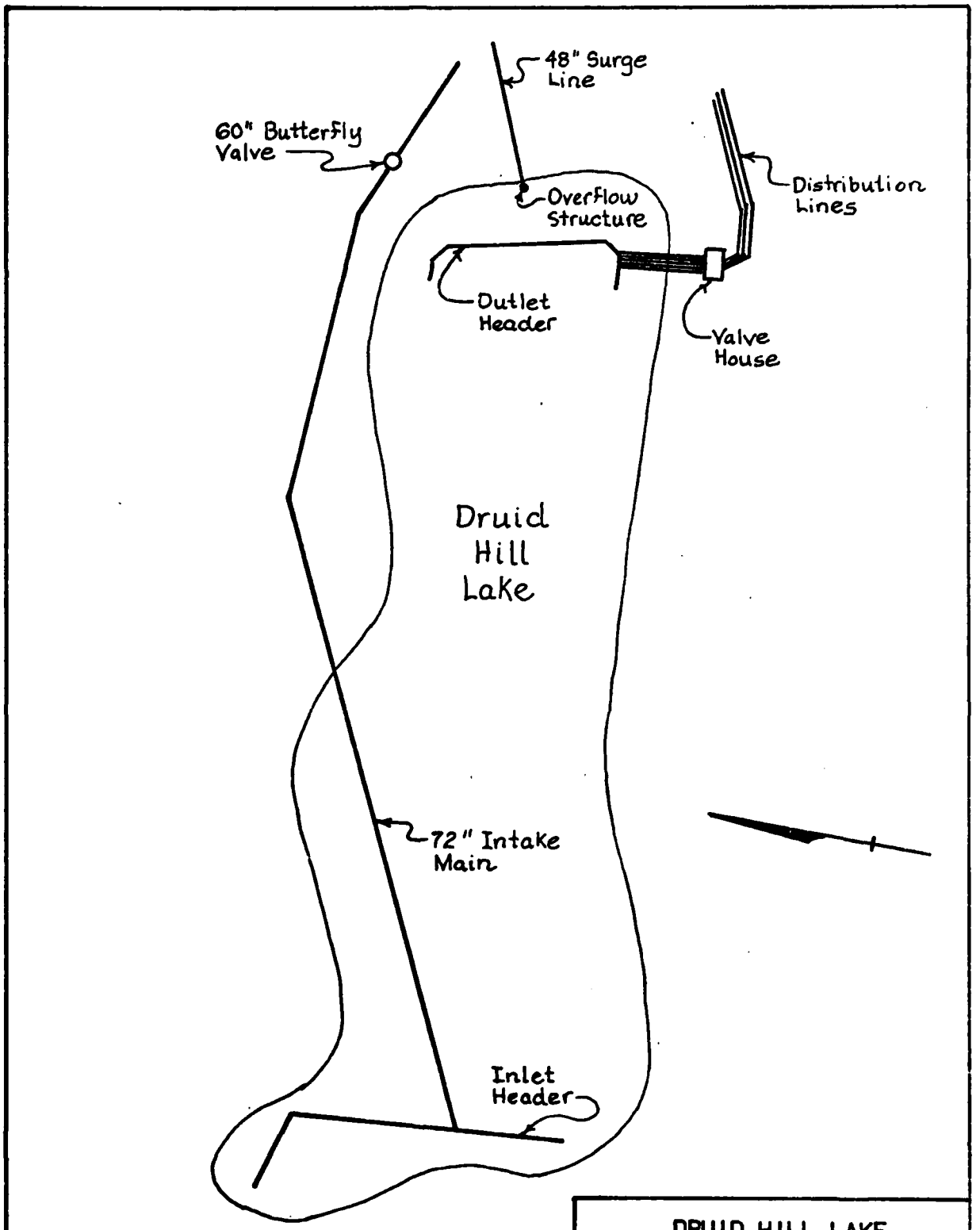
DRUID HILL LAKE

TRACED FROM PRINT

DATED SEPT. 1, 1933

BALTO. CITY FILE NO. W-109A-29230

PLATE E-



DRUID HILL LAKE

SCHEMATIC PIPING DIAGRAM

NOT TO SCALE

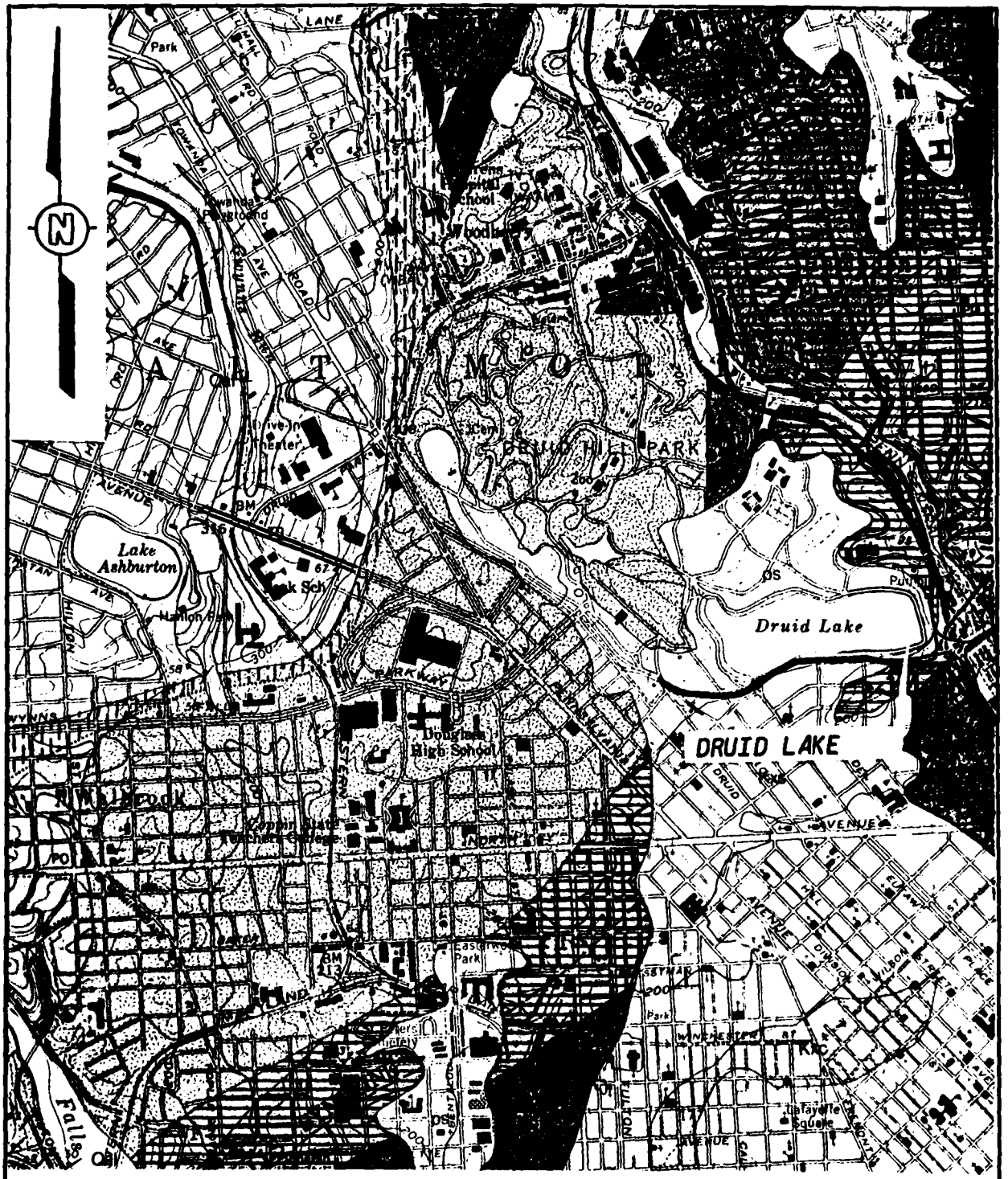
PLATE E-3

APPENDIX F

GEOLOGY

DRUID LAKE
APPENDIX F
REGIONAL GEOLOGY

The Druid Lake Dam is located within the Piedmont Physiographic Province and is situated on a thin stratum of unindurated sediments of the Cretaceous Potomac Group which lie unconformably on a complex of residual materials derived from the in-situ decomposition of rock strata of the Jones Falls Schist. The Potomac Group deposits are typically sands with silt and clay seams, and are anticipated to be less than 10 feet thick in the vicinity of the dam. The residual materials range from soil-like components, from thorough decomposition of the parent rock, to partial or slight decomposition of the rock mass. The Jones Falls Schist is characterized by a quartz-muscovite schist containing numerous pegmatite lenses and dips approximately 35^{o} to the northwest.



SCALE

1000' 0 1000' 2000' 3000' 4000'

REFERENCE:

GEOLOGIC MAP OF THE BALTIMORE WEST QUADRANGLE, PREPARED BY STATE OF MARYLAND, MARYLAND GEOLOGICAL SURVEY, DATED 1979, SCALE 1" = 2000'

DRUID LAKE

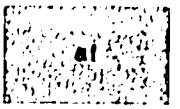
GEOLOGY MAP

RUMMEL, KLEPPER & KAHL

LEGEND

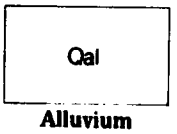
Jones Falls Schist

Medium- to coarse-grained biotite-plagioclase-muscovite-quartz schist, in places accompanied by fine-grained biotite-plagioclase-quartz gneiss in layers a few centimeters thick. Garnet, and less commonly tourmaline, occur in some outcrops. Includes very minor muscovite-plagioclase-quartz schist, quartzite, amphibolite, and muscovite-quartz-feldspar gneiss.



Artificial Fill

Consists of heterogeneous materials such as rock, unconsolidated sediment, slag, refuse, and dredge spoil. Only major areas of filled or highly disturbed ground have been mapped. Thickness 3 to 6 m (≈10 to 15 ft).



Alluvium

Interbedded gravel, sand, silt, and clay of varied composition and sorting. Typically confined to flood plains of perennial streams and upland gathering areas. Sediment size, sorting, and mineralogy are strongly controlled by the source rocks and geomorphic setting. The quartzose sand and polymict gravel are typically well bedded and loosely compacted; the silt and clay are often water saturated and poorly bedded. Minor amounts of colluvium (unmapped) may interfinger with alluvium at or near the bases of slopes. Structural symbols on alluvium represent bedrock exposures in stream valleys. These are typically either along the margins of the flood plain or close to the main channel of the drainage. Thickness 0.5 to 6 m (≈2 to 15 ft).

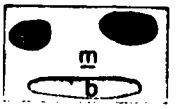
Cold Spring Gneiss

Uniform, fine- to medium-grained biotite-muscovite-microcline-quartz-plagioclase gneiss or schistose gneiss, locally devoid of muscovite. Commonly with small feldspar augen several millimeters in length and locally up to one centimeter. Age unknown.

Overprint: Cold Spring Gneiss injection complex. Areas in which the mapped rock formations include 50% or more Cold Spring Gneiss in sills up to tens of meters thick.

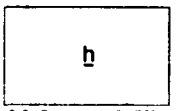
Potomac Group (?)

ps *Sand-gravel lithofacies. Poorly sorted to well sorted quartz sand containing variable amounts of vein quartz and quartzite gravel. Framework components are commonly coated with ferric oxide and are locally limonite-cemented. Varied amounts of silt and clay are present in lenses and pods and as matrix. Sand, where exposed below the soil zone, is typically planar to cross-bedded. Pebbles commonly range from 1 to 10 cm in diameter and are concentrated in coarse planar beds or are disseminated in finer sediments.*



Mount Washington Amphibolite

Fine- and medium-grained, generally massive amphibolite locally with pyroxene, and rarely with chlorite-rich zones several meters thick. Includes less than 10% actinofels and actinoschist as layers 2 centimeters or less thick, but in a few places several tens of meters thick. Serpentinite rare. Amphibolite typically uniform but locally exhibits layering on a scale of centimeters to tens of centimeters defined by variations in the amphibole/plagioclase ratio. Amphibolite locally includes irregular patches of lighter colored, coarser grained amphibolite (net veins). North of U.S. Rte. 40, generally but not invariably massive; south of U.S. Rte. 40, well foliated and not commonly massive. Where massive commonly crops out as cobbles and boulders in a clay-rich, red saprolite.



Hollofield Layered Ultramafite

Ultramafic and mafic rocks interlayered on a scale varying from centimeters to tens of meters. Chiefly actinofels and actinoschist with subordinate amphibolite and very subordinate serpentinite.

REFERENCE:

GEOLOGIC MAP OF THE BALTIMORE WEST QUADRANGLE, PREPARED BY STATE OF MARYLAND, MARYLAND GEOLOGICAL SURVEY, DATED 1979

GEOLOGY MAP LEGEND

RUMMEL, KLEPPER & KAHL

LEGEND

Patuxent Formation

Kxs *Sand facies. Highly variable, interbedded sand, gravel, silt, and clay locally indurated by ferruginous cement. Sand and gravel typically quartzose with a buff, kaolinitic clay-silt matrix. Sediments are organized into fining-upward packages 3 to 5 m (≈10 to 15 ft) thick consisting of planar-bedded gravel with clay clasts or cross-bedded sand at the base grading upward to laminated or massive silt-clay at the top. Elsewhere vertical sequences show abrupt sediment size changes and erosive contacts. The heavy mineral suite is characterized by staurolite, zircon, tourmaline, and kyanite. Sparse silicified and abundant iron-oxide replacements of both cycadeoids and coniferous wood are present throughout the formation. These sediments were deposited in high-gradient, braided to meandering streams.*

Kxc *Clay facies. Light gray to black or brown clay containing variable amounts of quartz silt and gravel; local concentrations of lignitic, partially pyritized wood or macerated leaf and cone debris are associated with some sideritic concretions. Thin planar beds of sand and/or gravelly clay are interbedded with massive clay. These isolated clay pods are thought to be accumulations on deflated surfaces such as abandoned stream channels or in pre-Cretaceous topographic lows.*

Thickness 2 to 35 m (≈7 to 115 ft).

James Run Formation

jf *Relay Gneiss Member. Fine- to medium-grained biotite-quartz-plagioclase gneiss, locally containing muscovite. Mica absent and magnetite present in some outcrops. Commonly cut by numerous randomly oriented joints.*

jc *Carroll Gneiss Member. Fine- to medium-grained biotite-quartz-plagioclase gneiss, locally with muscovite. Mica absent and magnetite present in some outcrops. Includes subordinate, concordant amphibolite in layers a few centimeters to tens of centimeters thick, but locally several meters thick. Facies equivalent of Druid Hill Amphibolite Member.*

jd *Druid Hill Amphibolite Member. Fine- to medium-grained, generally well foliated amphibolite, locally with irregular anastomosing patches of coarser grained, lighter colored amphibolite. Chlorite fels and actinofels, locally foliated, associated with the amphibolite in places. Includes subordinate quartzo-feldspathic gneiss and granofels to the south which increase northward to nearly half the volume of the unit. Scale of layering ranges from a few tens of centimeters to more than 10 meters. Felsic rocks are generally fine-grained and well foliated, but may also be coarser grained, massive, and intricately jointed.*

Overprint: *Pegmatite injection complex. Areas in which the mapped rock formations include up to 50% pegmatite, identical to that described above, commonly as concordant masses a few meters thick. In places associated with a finer grained, granitic or gneissic rock with the same mineralogy.*

REFERENCE:

GEOLOGIC MAP OF THE BALTIMORE WEST QUADRANGLE, PREPARED BY STATE OF MARYLAND, MARYLAND GEOLOGICAL SURVEY, DATED 1979

GEOLOGY MAP LEGEND

RUMMEL, KLEPPER & KAHL